

THE MINERALS INDUSTRY OF ANGOLA

Paul Jourdan

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# ***THE MINERALS INDUSTRY OF ANGOLA***

By  
Paul Jourdan

**INSTITUTE OF MINING RESEARCH**

University of Zimbabwe  
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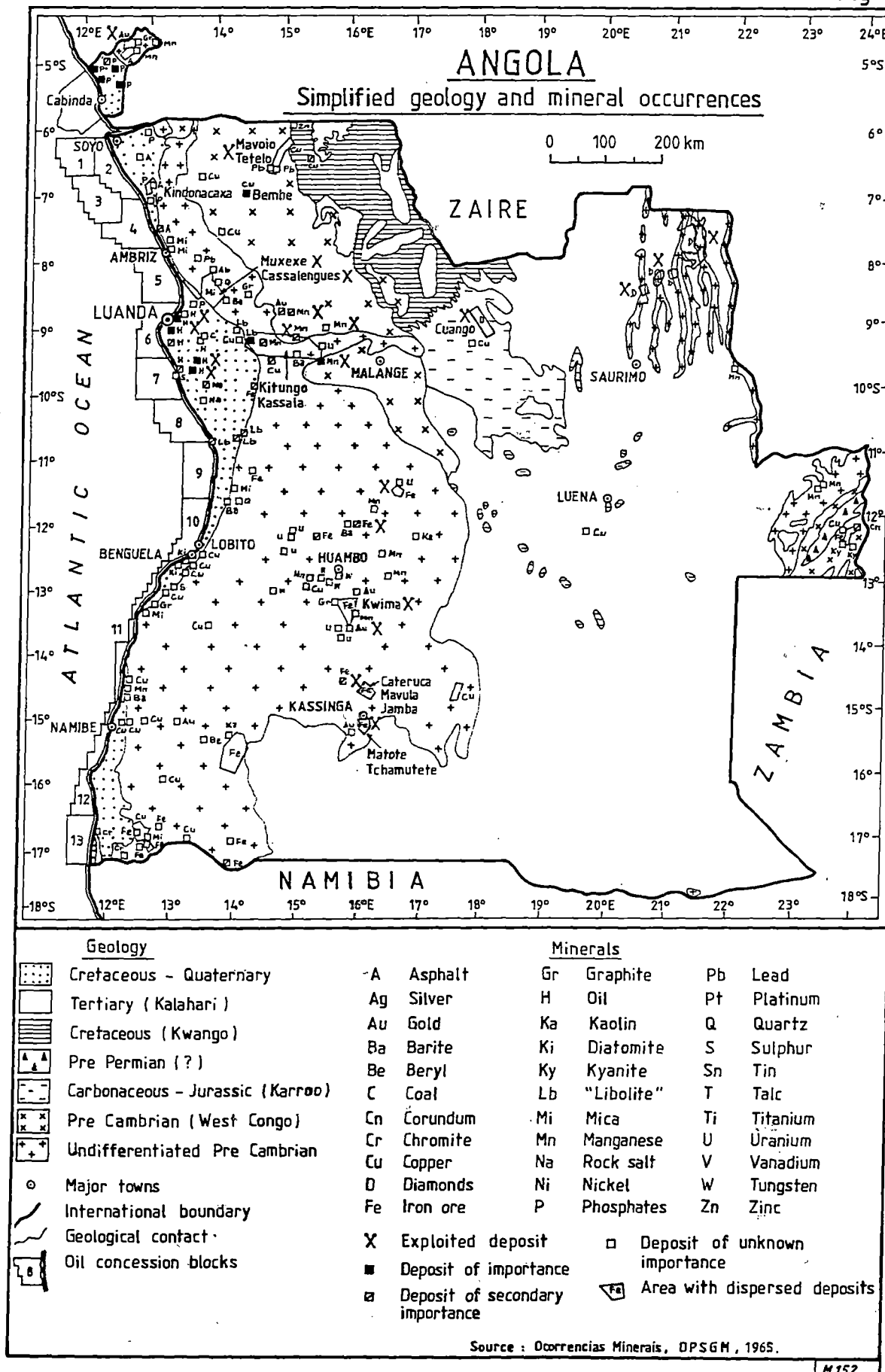
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Fig. 5  
MINERALS

## MINERALS



Fig. 6



# The Minerals Sector of Angola

## Background

### Introduction

Portuguese navigators first landed on the shores of present day Angolan territory in the second half of the fifteenth century. Subsequently Luanda grew into a major trading post for goods from the interior, initially ivory, slaves and gold, and later, wild rubber, coffee and diamonds.

At the Berlin Conference of 1885 Portugal formally lost control of the lucrative Zaire estuary to Belgium and their zone of influence on the south-west coast of Africa was restricted to Angola and the Cabinda enclave, but it was not until the beginning of the twentieth century that the subjugation of the interior was completed and effective control over the colony was exerted.

Artisanal mining and smelting of ferrous and non-ferrous metals has been undertaken in Angola for the last two millennia, but it was not until the early part of this century that large scale mining commenced when the financial conglomerate, Societe Generale de Belgique, extended its operations from the then Belgian Congo (Zaire) to the diamond fields of north-eastern Angola, via a sister company, Companhia de Diamantes de Angola (Diamang).

It is not known when Angolans first started using bitumen and viscous crude oil as a fuel, but certainly for several millennia. With the arrival of the Portuguese their commercial exploitation was first considered and in 1767 49 barrels of crude were shipped to Lisbon, but it was not until the 1950's that large scale exploitation commenced<sup>1</sup>.

### Recent History

In 1956 a nationalist movement, the Peoples Movement for the Liberation of Angola (MPLA<sup>2</sup>), was formed in Luanda with a view to obtaining independence from Portugal. A second movement, the FNLA<sup>3</sup>, was formed from an older tribal organisation, the UPA, and from Angolan refugees in Zaire and in 1966 a third movement, UNITA<sup>4</sup>, was formed from a split in the FNLA. All three movements waged guerrilla warfare against the Portuguese colonial armies, with varying effectiveness<sup>5</sup>.

In 1963 the Portuguese opened up the Angolan economy to foreign investment in an attempt to gain support from the Western powers in their struggle against the nationalists. It was this policy that led to the massive expansion of the Kassinga iron ore mines with the injection of international capital (Krupp of the FRG and Hojgaard & Schultz of Denmark). Exports of iron ore rapidly increased from 0.63 Mt in 1966 to 6.3 Mt in 1970 (900%). Crude petroleum production also increased dramatically with the participation of American and European oil companies (Gulf Oil and Fina Petroleum), from 0.54 Mt in 1967 to 8.2 Mt in 1973 (1420%). By 1973 minerals made up almost half of the total exports of the country, double that of a decade earlier.

In 1974 the new Portuguese government resolved to give independence to its colonies, but the three Angolan movements failed to come to an agreement and civil war broke out. The conflict was entered by South Africa with an invasion in the south, launched from its occupied territory, Namibia, and Zairean troops in the north, both of which were countered with the arrival of Cuban troops at the invitation of the MPLA. By April 1976 the MPLA and their Cuban allies had thrown out the Zaireans, South Africans, FNLA and UNITA.

Both UNITA and FNLA resorted to guerrilla warfare against the MPLA government in Luanda and the South Africans continued an undeclared war of destabilisation including regular invasions of the south

of the country and widespread sabotage actions including an attempt on the Gulf Oil installations in Cabinda. In the north Zaire continued to support the FNLA until the Zairean guerrilla movement, the FNLC<sup>6</sup>, operating from Angola and Zambia, in 1978 almost caused the collapse of the US backed Mobuto regime with an invasion of the mineral rich Shaba (ex-Katanga) Province. The total disintegration of Mobuto's forces was only averted by the arrival of French and Belgian paratroopers at Kolwezi. After this Mobuto quickly signed a "friendship" treaty with the Angolan government, but reports of Zaire being used as a rear base by anti-government forces continue, even though Angola has disarmed and controlled the activities of the FNLC in its territory.

In the south both the South Africans and Americans backed UNITA with equipment, training, logistics and, when UNITA bases were threatened, South African forces were sent in to protect them. After the major South African military setback at Cuito Canavale in 1988, in 1989 the MPLA, Cuba and South Africa came to an agreement on the withdrawal of South African troops from Angola and Namibia and Cuban troops from Angola and for the independence of Namibia, which took place in April 1990. With the loss of its rear base in Namibia, UNITA is reported to be now operating from bases in Zaire. Whether or not the Angolan Government will again counter by supporting Zairean dissidents is still unknown. The American government has pledged continued support for UNITA.

### The Economy

In 1975 90% of the roughly 360,000 Portuguese settlers fled the country, principally because of the war, depriving the new nation of almost all its skilled technical and managerial personnel. Due to 500 years of racist Portuguese education and employment policies there was only a handful of indigenous professionals on the eve of independence. Added to this was the enormous damage to the economy wrought by the invading South Africans in 1975 and early 1976, estimated at 6.7 GUS\$ at that time<sup>7</sup>.

The Angolan economy in 1973 was a typical Third World economy in the sense that it was vertically integrated into the economies of the developed capitalist economies by supplying ever cheaper raw materials to them and importing relatively more expensive finished goods from them. Local industry was tiny with almost all output destined for the small settler population. Therefore in 1976 the new socialist government was not only faced with the usual Third World problem of inheriting a satellite economy, but even this had been substantially destroyed by the second war of liberation and almost all skills had left the country. Added to this they also had to deal with a continuing undeclared war of destabilization by the RSA and USA and their surrogates (UNITA, FNLA and Zaire). From 1976 to 1981 South African damage to the economy was put at almost 1 GUS\$ and substantial damage has been wrought by them since then.

Table 1. ANGOLA: GOVERNMENT EXPENDITURE

	1981	1982	1983	1984	1985	1986	1987	1988
Expenditure (GKz <sup>1</sup> )	91.7	72.0	67.6	82.3	90.5	86.2	87.4	95.5
Sector (%):								
Econ. Development	47.3	36.6	26.5	26.6	26.0	15.9	14.9	17.5
Social Services	15.1	20.8	21.9	21.0	20.8	24.9	26.8	21.0
Defence	16.3	20.8	34.5	35.8	38.0	37.9	41.9	46.0
Administration	2.9	19.0	13.6	11.5	10.7	12.5	12.4	11.8
Other	8.4	2.8	3.5	5.1	4.5	8.8	4.0	3.8
Total:	100	100	100	100	100	100	100	100

<sup>1</sup>Kz: Kwanza, national currency (officially 30Kz=1USD)

Sources: Bhagavan 1986, INE, 1981/9.

The immediate concern of the new government was defence which accordingly received the largest part of the budget and a disproportionate share of skilled cadres. Logically the second concern was to finance the war, hence resources were channelled into the oil industry (Sonangol), the largest foreign exchange earner. By 1987 the oil extraction and refining industry accounted for 98% of exports as compared to 30% in 1973 and it constituted 43% of the GDP. As for the rest of the economy, large sections were nationalised in the wake of settler abandonment while other sectors virtually collapsed.

From 1981 to 1988 the allocation for defence almost trebled from 16% to 46% of the state budget, an expense that the battered economy could ill afford. Most of this increase was accounted for by a 73% drop in investment in "economic development" from 47% to 26% over the same period. With the decline of the manufacturing and agricultural sectors the Angolan economy has become increasingly dependent on the minerals sector, particularly the oil industry.

Table 2 ANGOLA: BASIC ECONOMIC DATA (current GKz)

Year	GNP	Structure of GDP (%)			Forex Rate Kz/US\$	Foreign Trade		External Debt
		Agri- culture	Manufact & Mining	Oil Prod & Refine		Exports	Imports	
1980	108.51				29.92	56.33	39.72	18.42
1981	117.98				28.48	55.52	49.72	40.86
1982	120 e				30.21	48.74	26.52	
1983	125.34	11.7	7.6	26.3	30.21	54.52	20.51	
1984	139.64	9.6	8.3	29.6	30.00	60.82	21.37	68.37
1985	140.98	8.4	9.2	32.4	30.00	66.97	19.69	74.87
1986	175.23	17.9	6.5	37.7	30.00	39.05	18.59	100 e
1987	195.48	13.6	7.5	43.0	30.00	64.88	13.37	152 e

e = estimate.

Sources: MPA 1986, EIU 1986, INE 1989.

Due to the declining economic situation, in 1987 the Angolan government introduced a new economic regime, SEF (*Saniamento Económico e Financeiro*), that allowed for private ownership in virtually all sectors except for banking and defence and allowed for generous conditions for foreign investment. This has not resulted in a rush of private takeovers or an inflow of foreign capital, partly due to the continuing war and partly due to the fact that the government has failed to bring the official exchange rate in line with reality. Investors are unlikely to want to invest in the production of products that then have to be sold at prices fixed in relation to the official Kwanza exchange rate (the parallel market rate is over thirty times the official one).

## The Minerals Sector

### Overview of the Minerals Sector

The minerals industry of Angola is, in terms of value, the largest in the SADCC, but this is almost entirely due to crude oil output. In 1987 Angola constituted 12% of the total SADCC population and 25% of the area; making it, after Botswana, the second least densely populated. Its GNP was 29% of the total, resulting in a GNP/capita 137% higher than the overall SADCC GDP of 298 USD, while it had 19% of the regional debt (58% of GDP).

In terms of minerals, Angola accounted for 57% of the total value of minerals produced in the region and the minerals industry contributed 45% of the country's GDP, equal to Botswana and more than double the SADCC average of 19%. Mineral exports were 98% of total national exports, 39% above the

regional average of 70% and the highest in the region. Due to its clear leadership in petroleum exploitation and refining Angola is the coordinating country for the SADCC Energy Sector which has its HQ in Luanda.

Mineral export dependence has increased from 22% in 1963, to 47% in 1973 and to 98% in 1987, more than a fourfold increase in 24 years. At the same time there has been an increasing dependence on one mineral, oil. In 1963 oil accounted for 13% of mineral exports, in 1973 64% and by 1987 oil and oil products constituted 95%.

Table 3. ANGOLA: PRINCIPAL EXPORTS, 1963, 1973 & 1987 (current GKz)

Commodity	1963			1973			1987		
	Vol.	Val.	% Total Exports	Vol.	Val.	% Total Exports	Vol.	Val.	% Total Exports
Diamonds Mcts	1.29	0.77	16.2	2.11	2.00	10.4	0.85	1.63	2.5
Iron ore Mt	0.66	0.14	2.9	6.33	1.21	6.3	-	-	-
oil, crude Mbbbl	0.32	0.13	2.7	7.32	5.76	30.1	116.0		
LPG kbbl	-	-	-	-	-	-	2.24		
Oil Products Mt							0.50		
							61.90	95.4	
Cement/clinker kt							36.6	0.04	-
Total Minerals(%):			21.8			46.8			98.0
Coffee kt	136.44	1.89	40.0	213.41	5.08	26.5	16.13	1.00	1.5
Sisal kt	62.98	0.58	12.2	53.40	0.47	2.4			
Fish kt	39.33	0.15	3.2	112.90	1.36	7.1	0.32	0.5	
other		1.08	22.8		3.28	17.1	0.3	0.03	-
Total Exports(GKz):	4.74	100.0		19.15	100.0		64.87	100.0	

Sources: Dilolwa 1978, Ministerio do Plano 1986, INE 1989.

Due to the security situation the variety of minerals produced has shrunk dramatically, although the value has increased due to the relatively "bandit free" nature of off-shore oil production; however, in May 1985 South Africa did attempt to sabotage the installations in the Cabinda enclave. Diamond production has continued, but since 1980 output has halved mainly due to bandit activity in the north-east of the country. The only other significant mineral production is quarrying for construction materials such as limestone, gypsum and granite.

At the 1977 and 1980 MPLA Congresses fundamental mineral policy was formulated in which priority was given to petroleum, diamonds, iron ore, phosphates, ornamental stones, underground water and copper exploitation. "...with a view to creating a balanced economy and conditions capable of generating the necessary surpluses for export".<sup>8</sup> This concentration on relatively few minerals (relative to Angola's resources) was due to the dearth of skilled mining personnel available after the settler exodus of 1975 and the security situation.

The minerals industry comes under two separate ministries: The Ministry of Energy and Petroleum, which owns the state oil company, Sonangol, and the Ministry of Industry. The Mining Law of 1979 created, under the Ministry of Industry, the National Directorate for the Mining Industry with its research arm, the National Institute for Geology (Inageo, Geological Survey Dept.), and the National Department for Mines which controls several state mining companies (Endiama, Ferrangol, Roremina, Minaquartzo and Fosfang).



Table 4. ANGOLA: MINERAL PRODUCTION (Volume)

	Unit	1973	1983	1984	1985	1986	1987	1988	1989	73-83	83-88
Diamonds	Mcts	2.12	1.03	.91	.72	.27	.87	1.04	1.32	-51%	1%
Fe, Iron Ore	kt	6052	0	0	0	15	0	0	0	-100%	nap
Fe, Steel	kt	35.7	3.0	4.4	4.1	7.0	1.0	2.0		-92%	-32%
Granite	m <sup>3</sup>	1432	0	466	336	0	139	1923	nap	-	90%
Gypsum	kt	92.2	6.5	6.0	11.7	13.1	12.9	23.7		-93%	262%
Kaolin	kt	.67	.00	.00	.00	.00	.00	.00	.00	-100%	nap
Limestone	Mt	.90	.15	.13	.26	.29	.29	.53		-84%	262%
Limst, Cement	kt		125	145	131	282	210	322	298	nap	157%
Manganese	kt	6.2	.0	.0	.0	.0	.0	.0	.0	-100%	nap
Marble	m <sup>3</sup>	1475	218	95	120	232	120	258	272	-85%	18%
oil, crude	Mt	8.0	8.9	10.2	11.6	14.1	18.0	24.6	24.4	11%	177%
oil, LPG	Mt	.00		2.71	3.16	3.51	4.27	4.40		nap	nap
oil, Prods.	Mt	.70	1.22	1.20	1.39	1.40	1.50	1.39		73%	14%
Phosphate	kt	.00	.00	.23	.00	.00	.00	.00	.00	nap	nap
Quartz	kt		.00	.02	.00	.00	.00	.00	.00	nap	nap
Salt	kt	96.7	7.9	34.0	50.0	47.0	65.0	55.0		-92%	596%

blank space = no data, nap = not applicable, Sources: INE 1986/9, SADCC Energy TAU, 1989, Dilolwa 1978, Sonangol 1988.

From 1973 to 1983 the production of most minerals dropped significantly, due to the settler exodus and the war, except for crude oil production. However, since 1983 the production of several minerals has improved, partly due to the better security situation in the south of the country.

### Legislation

Under the Angolan Constitution (Fundamental Law) all mineral resources "...are the property of the State, which shall determine the conditions of their exploitation..."<sup>9</sup>. The Petroleum Law of 1978 governs all hydrocarbon exploration and production in Angola and under it Sonangol is the sole concessionaire with the right to explore for and produce petroleum, but can enter into association with foreign partners to achieve this.

The association is for an agreed duration, divided into exploration, development and production periods. The law also has provisions for matters relating to conservation of resources and the environment, the utilisation of natural gas, the training and utilization of Angolan personnel and the participation in management of Sonangol in any association. Sonangol's share in any association operating in less than 150 m of water is set by the law at a minimum of 51%. There are two basic forms of association, namely, "production sharing agreements" and "joint ventures".

**Joint Ventures:** Under this form Sonangol is the part owner of the operation and its production share is proportional to its investment. This type of association was inherited from the colonial period and is the form for the Cabinda, Cabgoc, operation, in which Cabgoc is the technical operator for the venture. This is also the form for the onshore Congo and Kwanza operations.

**Production Sharing Agreements:** In this case the foreign operator acts as a contractor to Sonangol, is responsible for all of the investment and risk and receives a share of production in return. This form of association was initiated after the division of the continental shelf in 1978 into 13 Blocks. Under it there is also a "price cap" provision where there is a price cap for profit sharing, based on the UN cost inflation index. All profit in excess of this price cap goes to Sonangol<sup>10</sup>. In this way the capture of windfall and

monopoly rents is guaranteed.

A revision of the Mining Law was enacted in 1987 (Lei 11/87) which brought it more in line with the Petroleum Law in that foreign participation (for production sharing) at the early stages of exploration and feasibility studies will be encouraged for projects that will be mainly export oriented. This is being done because, at the present time, the state does not have the capacity for an expansion in exploration activity. The types and responsibilities of the associations are as defined by The Law on Foreign Investments in which the repatriation of after tax profits is allowed up to a limit of 25% of invested capital.

## The Petroleum Industry

### Oil Production

Oil exploration by the "Canha & Formigal" company started in 1910 in the Congo and Kwanza basins and in 1915 the first well was sunk in the Kwanza basin. The basins are typical of the passive margin type, associated to continental drift. Most of the reserves (Cabinda) are of lower Cretaceous (Albian) and Upper Jurassic age. A significant salt layer divides the sequence from rift type to continental margin type and serves as the important cap rock for the petroliferous sediments below. The crude is basically a good quality light (about 36 degrees API, 0.8 SG) but can be extremely variable.

Production started in 1955 and in 1958 was 58 Mt from the Kwanza field. Production subsequently started up in the Cabinda and Congo basins. From 1968 to 1969 production jumped 224% from 0.75 Mt to 2.4 Mt and replaced coffee as the country's premier export. By 1973 production had increased 236% (relative to 1969) to 8,175 Mt, 90% from the Cabinda basin (off-shore), 7% from the Kwanza basin (on-shore) and 3% from the Congo basin (on-shore)<sup>11</sup>.

Table 5. INDEXED VALUE OF CRUDE OIL EXPORTS (1975=100)

Year	US GNP deflator	1975=100	Price (US\$)	Indexed (US\$)	Exports (Mbbl)	Indexed Value
1970	91.45	137.23	1.30	1.30	31.29	9.62
1971	96.00	130.73	1.70	1.62	34.80	13.33
1972	99.98	125.53	1.90	1.74	50.06	20.57
1973	105.68	118.75	2.70	2.34	53.68	29.66
1974	114.95	109.18	11.20	8.91	54.24	114.29
1975	125.50	100.00	10.90	7.94	53.24	100.00
1976	132.10	95.00	11.70	8.10	31.15	59.67
1977	140.03	89.62	12.80	8.36	55.50	109.71
1978	150.35	83.47	12.90	7.85	37.10	68.84
1979	163.40	76.81	18.60	10.41	42.90	105.61
1980	178.43	70.34	30.50	15.63	40.90	151.19
1981	195.60	64.16	35.60	16.64	38.14	150.12
1982	207.40	60.51	31.40	13.85	39.26	128.54
1983	215.30	58.29	27.80	11.81	54.85	153.16
1984	222.90	56.30	27.20	11.16	64.16	169.32
1985	230.00	54.57	25.90	10.30	72.82	177.34
1986	237.00	52.95	12.29	4.74	92.30	103.51
1987	246.00	51.02	15.45	5.74	116.00	157.55
1988	255.00	49.22	13.35	4.79	155.60	176.17

Douglas 1983, Council of Economic Advisors 1990.

Production from the latter two basins peaked in 1974 at 172 kbbl/day and has since been on the decline as the reserves are depleted, while both the reserves and production from the off-shore fields (Blocks 0, 2, and 3) has been on the increase. By 1986 both production and reserves were double that of a decade

earlier and reserves are presently estimated to be good for twelve years at present production rates. From 1975 to 1985 the rate of reserves discovery was twice the extraction rate.

Production in 1988 was 24.6 Mt (452 kbbl/day), almost four times the 1980 figure and is still on the increase. Production costs are estimated to be about 5 USD/bbl, well below even the lowest world market price over the last ten years. In 1988 exports of oil and oil products were worth 61.9 GKw, 95.4% of total exports, a 40% increase on 1980 (44.1 MKz). The 1988 volume of oil exports was three times greater than 1975, but the real value of exports was only 76% greater due a fall in the real unit value of 40%, but the oil price picked up steadily in 1989<sup>12</sup>.

Pre-independence, the main companies were: in Cabinda, Cabgoc (Cabinda Gulf Oil Company) owned by Gulf Oil of the USA; in Kwanza, Petrangol, 30% owned by the colonial state, but controlled by Petrofina of Belgium; and, in the Congo Basin, there were a variety of companies including Petrangol, Angol (Portuguese), Texaco (USA) and Total (French). In 1972 Cabgoc gave up its Cabinda onshore concession and in 1976, due to the USA's support for the Zairean/FNLA/mercenary and the RSA/UNITA/mercenary invasions of Angola and its refusal to recognise the MPLA government, production stopped for six months causing output to fall from 48.8 Mbbl (1975) to 28.6 Mbbl (1976). After the passing of the Petroleum Law in 1978, Sonangol acquired a 51% share of the association.

The state oil company, Sonangol (Sociedade Nacional de Combustiveis de Angola), was formed in 1976 and under the Petroleum Law of 1978 (law 13/78) Sonangol became the exclusive concessionaire for hydrocarbon exploration and production. It acquired the operations of Angol (Portuguese) and entered into a series of joint ventures and production sharing agreements with the oil transnationals. During 1977-78 Sonangol became a 51% participant in an off-shore Cabinda joint venture with Cabgoc (Gulf Oil, now owned by Chevron) in which production is shared at a 51:49 ratio. Sonangol also has joint venture operations in the Congo and Kwanza basins with Texaco (USA) and Petrofina (Belgium). By 1984 Sonangol "owned" approximately half of Angola's oil production through equity participation and production sharing.

Elf Aquitaine of France was a late-comer to the Angolan oil industry when a production sharing contract was signed in 1980 for offshore Block 3 west of Block 1, off the northern Angolan coast. The association was made up of Elf 50% (operator), Mobil 25%, Agip 15%, Ina Naftaplan 5% and Naftagas 5%. In 1984 Mitsubishi (Ajoco) bought Mobil's share<sup>13</sup>. From 1981 to 1988 over 300 km of wells were drilled and in the first year the Palanca field was discovered, followed by a series of further discoveries in 1982, 1985 and 1987. Production started in 1985 (8 Mbbl) and was 150 kbbl/day (about 7.4 Mt/an) in 1989.

In 1987 the Cabinda association became: Sonangol 51%, Cabgoc 39.2% and Agip (Italy) 9.8%. This was in part due to the fact that the USA continues to support the destabilisation of Angola and still refuses to recognise the Luanda government, provoking fears that Washington might force Gulf to withdraw. The inclusion of an alternative, non American, oil company (Agip, Italian state company) that could take over as operator was seen as a precaution in this regard. Until recently there were Cuban troops helping protect American oil companies from American supplied UNITA insurgents and South African sabotage squads.

In 1988 the company breakdown of Angolan oil production was:

Table 6 ANGOLA: 1988 OIL PRODUCTION

Operator	Area	kbbbl/day	%
Cabgoc	Carbinda offshore	267.8	60%
Elf	Offshore block 3	110.6	25%
Fina	Onshore	35.6	8%
Texaco	Offshore block 2	32.6	7%
Total		446.6	100%

Source IEU 1989.

In 1978 the Angolan continental platform was divided into 14 exploration blocks (to a depth of roughly 200m) and Sonangol formulated production sharing and/or joint venture agreements for eight of these concessions with several oil companies. Sonangol also has joint ventures for companies which service the petroleum industry, an example of which is Petromar which builds off-shore oil installations, submarine pipelines and port facilities, at the port of Ambriz (north of Luanda).

#### *Oil Refining*

In 1958 a small refinery (2 kbbbl/day) was opened in Luanda by Petrangol and in 1972/3 it was substantially expanded to refine 30 kbbbl/day (1.5 Mt/an). It is a hydro-skimming refinery primarily for the production of gasoline, jet fuel and gas oil for the domestic market. At present the product mix of the refinery is not compatible with Angolan consumption and some petroleum products still have to be imported (142 kt in 1987, 78% jet fuel). The refinery was expanded in 1987 by a Portuguese contractor to handle 1.6 to 1.75 Mt/an, depending on the crude used. The current crude is from offshore (Block 3, Elf) which is much lighter (38.3 API) than the previous feed from onshore Soyo. In 1988 the refinery produced 1.4 Mt of oil products, of which 0.57 Mt were exported<sup>14</sup>. In 1986 there was a major investment of 9 MUSD to create an autonomous electricity generating capacity for the plant, in case of a power cutoff due to sabotage of the electricity supply, which can also supply parts of Luanda in case of emergency.

#### *Natural Gas*

In 1982 two feasibility studies for the establishment of an ammonia plant based on natural gas were undertaken by Arthur D. Little (UK) and the International Gas Development Corporation (USA) and in 1984 a regional (SADCC) fertilizer market survey was undertaken by Cramer and Warner (UK) funded by the Commonwealth Secretariat (CFTC). These studies resulted in a proposal for the construction of a plant to produce 1100 t/d of ammonia and 1800 t/d of urea, at a cost of roughly 500 MUS\$. It is planned to locate the plant near Soyo in the extreme north-west of the country, close to Blocks 1, 2 and 3, the source of the gas. The gas reserves are considered good for the life of the plant (20 years).

Soyo is only 80 km north of the Kindonocaxa phosphate deposit and the possibility of establishing an integrated phosphate/urea fertilizer plant is under consideration. The production of PVC from propane in the gas of Blocks 3 and 4 is also being investigated as part of the ammonia project. At present, finance for the project is being sought from south-east Asian companies, specifically South Korea (consortium led by Daiwo Corp.), in which the backers would take the majority of production as the regional (SADCC) market represents only 10% of projected output.

Natural gas is also used for both gas lift and injection to boost crude oil production and for the production of LPG<sup>15</sup> for export at the rate of 4 to 5 Mt/annum.

### ***Asphalt***

Angola also has reserves of asphaltic rocks in the Cabinda basin, the Congo basin (Gondo and Musserra) and the Kwanza basin (exploited in the past). In Angola the name “libolite” has been given to natural bitumen (tar) as a large deposit occurs at Libolo near Kwanza. Deposits of “libolite” are also found at Kilundo, Kirimbo and Porto Amboim. Between 1948 and 1973 roughly 810 kt (30 kt/an.) of asphaltic rock were produced with a bituminous content of 18 to 22%, principally for road surfacing<sup>16</sup>. Exploitation of this resource has ceased as the output of bitumen from the refinery covers local needs at present. The deposits were considered for refining into petroleum products in the mid-eighties but the cost was well above market prices for the products. In general, the tarred roads of the region are in an awful state of repair, often for the lack of forex to import bitumen, yet Angola has huge natural resources that could be exploited at almost no cost other than the cost of transport.

### **The Mining Industry**

#### ***Diamonds***

The first systematic prospecting for and exploitation of diamonds in Angola was by Companhia de Pesquisas Mineiras (Pema) in the northeast of the country (Lunda) in 1913. In 1920 this was taken over by Companhia de Diamantes de Angola (Diamang) which was owned by Societe General de Belgique (SGB) 18%, Portuguese financial concerns 16.4%, the Diamond Corporation (De Beers) 1.7% and the public (mainly Portuguese), 49%.

In 1922, Ernest Oppenheimer of Anglo American (South Africa) managed to secure the selling rights for all of Diamang's production as part of his international bid to control the diamond market and thereby get control of De Beers, the largest producer. In 1929 Anglo American took over De Beers and Oppenheimer became Chairman and in 1934 the Diamond Producers Association was formed, dominated by De Beers, which to this day has a virtual monopoly over diamond marketing via the Diamond Trading Company and its Central Selling Organisation (CSO).

Until 1964 all of Angola's official sales were to the CSO in the UK, but from that year a proportion of the most valuable diamonds went directly to the Sociedade Portuguesa de Lapidacao (Dialap), paid for in Portuguese escudos rather than UK pounds.

Diamang had exclusive exploitation rights over 81% of the country and maintained a “state within a state”<sup>17</sup> particularly in Lunda district where it ran its own police force, administered justice, maintained a standing army of mercenaries and was responsible for agriculture, health, education, etc. Contrary to the migrant mining labour supply systems common in the rest of southern Africa, Diamang encouraged the formation of a permanent labour force which stood at 25 thousand in 1973.

In 1971 Diamang ceded most of its diamond exploration and mining rights (except for the Lunda and Kassanje areas) to Concorcio Mineiro de Angola (Condiamang), a local prospecting arm of De Beers, 45% owned by De Beers, 45% by Diamang and 10% by the Angolan colonial state.

From 1950 to 1957 exports ran at between 700 and 800 kcts/annum, representing from 7 to 13% of total exports by value. From 1958 exports steadily increased to a peak of 2,503 kcts in 1970 (19% of total exports) before falling to 0.27 Mcarats in 1987, due to the security situation in the north-east where the

diamond operations suffered several UNITA attacks in the 1980s. Production has since improved to 1.31 Mcarats in 1989. It should be borne in mind, however, that these figures are for “official” exports. A significant proportion of production has always been smuggled (up to 50%)<sup>18</sup>.

Table 7. ANGOLA: DIAMOND PRODUCTION (Mcts)  
AND PERCENTAGE OF EXPORTS

	1970	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Prod	2.5e	1.49	1.40	1.22	1.01	0.92	0.72	0.27	0.87	1.04	1.31
%Exp	19.2	12.7	11.9	11.5	5.6	4.7	3.3	0.8	2.5	na	na

na: not available, Sources: Dilolwa 1978, INE 1989.

In 1973 60% of Diamang’s output was gem grade and 40% industrial grade, a gem-to-industrial ratio that was only bettered by Namibia (CDM). In that year there were 45 open pit alluvial diamond workings in Angola. At present the grade of production is running at greater than 90% gem quality.

The state diamond company, Empresa Nacional de Diamantes de Angola (Endiama), was created after the passing of the Mining Law of 1979 and is responsible for diamond prospecting, mining, processing and marketing. The main mining areas are Lucapa, Cassanguidi, Andrada, Maludi, Cuanga and Calondo, in the centre-north and north-western part of the country. All the mines are open pit alluvial workings using heavy medium separation.

Until the end of 1985, an indirect subsidiary of De Beers, Mining and Technical Services (MATS) of the UK, was providing administrative, technical and marketing services to Endiama’s mining subsidiary, Diamang, but the contract was not renewed. Since then Diamang was dissolved, in 1986, and Endiama has created three mining operations:

- 1) A joint venture with RST<sup>19</sup> International (Cuango area)
- 2) A joint venture with SPE<sup>20</sup> of Portugal (Lucapa area)
- 3) Endiama on its own (Andrade and Lucapa area)

This system appears to have worked well in that production increased to 1,316 kcarats in 1989, but it is reported that Filipino workers have been imported to do much of the work. RST International comes from the Amax holding in Zambia Consolidated Copper Mines (ZCCM) which was bought out by a Greek entrepreneur, Sardanis, who was one of the directors nominated by the Zambian government on the board of Nchanga Copper Mines (RST) in the early seventies, after nationalisation. SPE, in which Sibeka has a holding, apparently has access to the Portuguese staff previously employed by Diamang.

Until 1986 official output was marketed through the CSO but since then Endiama has managed to secure higher prices<sup>21</sup> through a contracts with UK (Industrial Diamond Corporation), Belgian (Steinmetz-Evans) and US (Lazare Kaplan) companies. This arrangement was put together with advice from Martyn Marriott of DCI<sup>22</sup> who advised the Botswana government on its early, relatively favourable deal, with De Beers in theseventies. However it has been reported<sup>23</sup> that talks have been held with De Beers on the possibility of Endiama re-entering the CSO fold, but only if De Beers agrees to develop Angola’s huge diamond kimberlite pipe potential. The main advantage of in situ pipe mining is that it is concentrated in one locality and therefore easier to defend than the scattered alluvial workings. The main disadvantage is the large initial capital outlay (about 500 MUS\$). There are 638 reported kimberlite pipes, 300 of which are thought to have economic grades, some of which are among

the ten largest in the world. The possibility of using Soviet expertise to develop these pipes is also being pursued.

Angola's alluvial diamond mining potential is considered to be several orders greater than present output, worth well over 0.5 GUS\$/annum if developed. Reserves have been calculated at 90 Mcts but the potential is estimated at 350 Mcts (UNTCD, 1980). The main limitation to the expansion of this sector is the security situation in the north-east of the country.

### *Iron and Steel*

The iron ore mining firm, Companhia Mineira de Lobito, started up in 1929 with Portuguese capital (Sousa Machado family), but only obtained its first major mining concessions in 1949. A second mining company, Sociedade Mineira de Lombije, owned by the same family, acquired a mining concession for Kassinga iron ore deposits in 1953 and was later integrated into the Companhia Mineira de Lobito (1968). The major capital injection came from Krupp (FRG), Jogaard & Schultz (Denmark) and a Portuguese company of 1.3 GKz to the Lombije company for the opening up of the Kassinga mines, for putting in the railway to the port of Namibe and for the construction of the ore terminal. In 1965 Krupp loaned the Lobito company 1.5 GKz for the purchase of locomotives and rolling stock to move the ore<sup>24</sup>.

From 1969 to 1973 exports oscillated between 5 and 6.4 Mt. In 1973 6,330 kt were exported and 6,052 kt were mined. In that year 94% of production came from the opencast Kassinga mines of Jamba and Tchamutete with the rest coming from Mulanje district (Mounts Saia and Tumbi). The mines at Kwima (Huambo district) had been inactive for some time. The known high grade secondary haematite ores at Kassinga were virtually exhausted by 1973 and exploitation of the huge primary itabirite reserves was planned. These were to be pelletized at the rate of 6 Mt/annum of pellets. The Kassinga reserves occur in pre-Cambrian banded ironstones as secondary (high grade) haematite ores, residual and elluvial "pebble ores" and primary (low grade) itabiritic ores<sup>25</sup>.

With the South African invasion from the south in 1975 and their subsequent regular incursions into southern Angola, mining at Kassinga came to a standstill. In 1981 the state iron and manganese mining company, Empresa Nacional de Ferro (Ferrangol) was formed. Since its creation it has mainly been involved in the rehabilitation of the Kassinga operations, aided by Austromineral (Voest-Alpine, Austria) who have had a technical consultancy contract with Ferrangol. The reserves at Kassinga of detrital ore (40-45% Fe) have been reassessed at 100 Mt (cut off grade of 40%), while the reserves of lower grade (30-35% Fe) primary ores stand at greater than 1 Gt.

Mining of the detrital limonite-haematite-martite ore at the rate of 1.1 Mt/year of concentrate (72-74% Fe) has been planned for some time.

"However, mining is unlikely to start up again in the foreseeable future for two reasons: the railway to Namibe needs extensive rehabilitation and world market prospects are much worse than had been forecast..."<sup>26</sup>

Angola has numerous other iron ore deposits (see map) the most important of which is the huge Kassala-Kitungo resource, in the Kwanza-Norte Province 150 km ESE of Luanda. Pre-independence this deposit was evaluated by the Companhia de Manganês de Angola, but was never exploited. The Kassala and Kitungo deposits are situated 7 km apart and contain an estimated 300 Mt of primary ore grading 30 to 35% Fe, mainly in the form of titanomagnetite in a country rock of norite. A project for the production of 2.5 Mt/year of pellets using a slurry pipeline to Luanda has been put on ice by Ferrangol, due to the high initial investment cost of roughly 500 MUS\$.

The state enterprise Siderurgia Nacional in Luanda is the only producer of steel in the country. It used

to belong to the Champalimand (Portugal) group of companies and initially rolled rails from imported ingots. In 1972 a small 18 ton arc furnace was installed for the production of ingots. At present it is smelting local scrap only as pellets are still not locally available. Production of ingots in 1974 was 28.8 kt of ingots from which 26.6 kt of rod were rolled (capacity 50 kt/an). By 1988 production had fallen to 2 kt of steel. A separate state company, FATA, imports steel sheet for the production of tube and angles.

The possibility of establishing a 1.0 Mt/an DRI<sup>27</sup> plant using natural gas to produce sponge iron as a feed for a 150 kt/an steel plant (EAF<sup>28</sup>, expansion of Siderurgia Nacional) is under consideration by government<sup>29</sup>. Angola imports about 40 kt/an of steel as raw or semi-manufactured items and a UNIDO study done in 1986 projected that the crude steel equivalent of steel-based imports would be 93 kt/an in 1995 (base case)<sup>30</sup>.

### ***Manganese***

Manganese ore was produced at the Kiaponte and Kitota mines in Malanje Province until 1973 by the Companhia do Manganese de Angola. Over thirty years from 1943 to 1973 604 kt of ore were extracted<sup>31</sup>. The main occurrences are the Maiombe region (Cabinda), the Lucala region (Kiaponte and Kitota mines, Cuanza Norte and Malanje), Quicama (Bengo) and Capuia (Huambo). There are also many other occurrences. Reserves in the most important region (Lucala) are estimated at 5 Mt of high grade ore (55-56% Mn), but large areas have not been assessed<sup>32</sup>. Ferrangol is also responsible for manganese exploitation, but has no plans for the reactivation of the mines.

### ***Phosphates***

Angola has significant reserves of phosphates in the Cretaceous-Quaternary sediments north of Luanda and in Cabinda. A state company, Empresa Mineira de Fosfatos do Zaire (Fosfang), has been created to handle the exploitation of phosphates. The main resource is near the coast at Kindonacaxa, about 40 km north of the small port of N'zeto. The phosphates in this zone are of marine origin in the form of cropolites and reserves have only been determined for a small area of 18 km<sup>2</sup> where there are 7 Mt of phosphate rock grading 29.4% P<sub>2</sub>O<sub>5</sub>. Reserves for the whole zone are estimated to be greater than 200 Mt. In 1982 an experimental pilot processing plant was set up at Kindonacaxa to concentrate the phosphate rock by Fosfang in collaboration with Bulgargeomin (Bulgaria). The plant operated at a rate of 15 kt/annum for 1983 and 1984, then shut down due to problems in the distribution of the product to the agricultural users in the centre and south of the country. The project will recommence as soon as conditions allow.

The other major reserves are located in Cabinda Province and are different to those of Kindonacaxa. Energoprojekt of Yugoslavia has been assessing these deposits and prognostic reserves are estimated at roughly 200 Mt. One of the deposits, at Mongo-Tando, has 40 Mt of reserves grading 31.4% P<sub>2</sub>O<sub>5</sub>. The polymetallic deposits of Tetelo-Bembe-Uige have been considered for the production of sulphuric acid as a by-product from the processing of sulphide minerals for the manufacture of super-phosphates, as has the sulphur in natural gas.

### ***Marble***

Angola has several deposits of high quality marble, but only two quarries are in operation, due both to the shortage of skilled personnel and to the security situation. In 1973 1,457 m<sup>3</sup> were quarried but the present output is only 20% of this at roughly 270 m<sup>3</sup> per year for the domestic market.

The quarries are run by the state company, Roremina (Empresa Nacional de Rochas Ornamentais),



which has its HQ in the south of the country at Lubango, in the region of the deposits. The quarrying of marble will be expanded as soon as conditions permit.

### *"Granite"*

Roremina is also responsible for the exploitation of ornamental "granite" and it operates several quarries in the south of the country in the region of Chicuatite near Lubango. The black granite is a dark anorthosite and the Angolan product is internationally recognised. In 1973 output was just under 8,000 m<sup>3</sup>. Production in 1989 was 599 m<sup>3</sup> of "black granite", 526 m<sup>3</sup> of "grey granite", 798 m<sup>3</sup> of "red granite" (total 1923). All production is exported to Europe via the port of Namibe. In 1980 it was estimated that with improvements in stone cutting techniques and marketing, production could be increased to up to 20,000 m<sup>3</sup>/annum worth roughly 12 MUS\$, as the Angolan product has a ready market<sup>33</sup>.

### *Quartz*

The state crystalline quartz quarrying company, Empresa Mineira de Quartzo (Minaquartzo), is located in the south of the country in Kwanza Sul Province. The high purity fusing quartz occurs in the Condo region where the Pocaria I orebody is mined and has reserves estimated at 0.9 Mt in three veinlike orebodies, but there are also several other unassessed veins<sup>34</sup>. Due to its high quality the quartz competes favourably on the world market, but there has been no production since 1985 due to the security situation.

### *Cement*

There are two cement plants in the country, in Luanda and Lobito. Cement production was 311.7 kt in 1968 and peaked at 767.6 kt in 1973. By 1988 production had decreased to 322 kt. The producing companies used to be Secil (Luanda) and Companhia de Cimentos de Angola (Lobito), but the latter company is not producing at the moment, while the former is now a mixed state enterprise called Cimangola (Empresa de Cimentos de Angola) in which the state has a majority shareholding and 31% is held by a group made up of F.L. Smidth & Co. and Hojgaard & Shultz of Denmark who have a management and service contract. The Lobito company is now completely state owned and is called Encime (Empresa Nacional de Cimento).

### *Copper*

The copper deposits in Uíge Province in the north used to be mined by Empresa do Cobre de Angola which was linked to a Portuguese monopoly (CUF, later became Simeira). The three main deposits are at Mavoio, Tetelo (1 km apart and about 120 km north of Uíge) and Bembe. These are metasomatic type deposits occurring in the West Congo formation and the copper is found in limestones and calcareous shales or sandstones of the "Schisto-Calcaire" Series, generally associated to the Luango Fault Zone. It is estimated that the Mavoio and Bembe mines produced some 170 kt of copper between 1939 and 1963 when mining ceased.

Geological (inferred) ore reserves of the Tetelo-Bembe "zone" are estimated at 10 Mt at 2% Cu. Although copper is the main metal there are also associated elements such as vanadium, cobalt, barium, lead, zinc, gold and silver<sup>35</sup>. The National Directorate for the Mining Industry is at present interested in setting up a joint venture for the exploitation of the polymetallic sulphide deposits of Uíge Province, dependent on an improvement of the security situation.

The major other copper "zone" is the extension of the Zambian Copperbelt metallogenic province in Alto Zambeze in the extreme east of the country. Here inferred reserves are put at 10 Mt grading 1% Cu. Due to the extremely isolated location of these deposits, there are no plans for their development at present. There are also numerous other superficially known copper deposits in Angola, especially on

the contact between the Cretaceous coastal sediments and the pre-Cambrian basement south of Lobito<sup>36</sup>.

### ***Gold***

Gold occurs in numerous locations across the country generally in alluvial deposits. Up to 1965 about 560 kg of gold was produced in Angola from rudimentary small-scale mines, but all mining has since ceased. The main deposits are at Maiombe (Luali River, Cabinda), Lombige (Lombige River, Cuanza Norte), Gaudovira (Cunene River, Huila and Huambo), Chipindo (Cuengue River, Huila) and Cassinga (Colui River, Cunene)<sup>37</sup>. The most favourable prospects are Chipindo (M'popo mine) and Lombige, both of which were exploited in the past. In addition to the alluvial recent and fossil placers, the gold also occurs in small but numerous quartz veins associated to "greenstones". Reserves at M'popo are estimated at 5 tonnes of gold grading 6-10 g/t<sup>38</sup>.

### ***Carbonatites***

Angola has at least 14 carbonatite complexes. The two most important are Coola and Serra da Neve-Tchivira. These offer prospects for the future mining of nepheline, fluorite, niobium-tantalum, apatite and rare earths, but no work is being done on them at present. Fluorite reserves at Coola are estimated at 5 Mt grading 71%  $F_2Ca$  and at Tchivira 6 Mt at 27-61%  $F_2Ca$ .

### ***Exploration***

Angola has a presently unknown mineral potential as only 20% of the country has been geologically mapped at even 1:250,000 scale, let alone detailed surveys. There are undetermined reserves of chromite, platinum and nickel in the extreme south-west of the country, various alluvial gold deposits, several tungsten deposits in the centre of the country and numerous other mineral occurrences that lack systematic appraisal. The first step in the development of the Angolan mineral potential is to systematically survey the country. To this end the INAGEO has made some progress in training personnel both locally and overseas. The major obstacle to the expansion of exploration activity is still the low capacity of the Geological Survey Department (INAGEO) and the security situation. It is hoped that the former will be overcome by joint mineral exploration ventures with private capital.

### ***Discussion***

Until Salazar's "open-door" policy to Western investment in the sixties, the mineral sector of Angola consisted of a few, generally artisanal, mines except for diamond production in the north-east which had started on a large scale in the twenties. The huge mineral resources had hardly been touched by the Portuguese and the country was geologically unknown. This was principally due to Portugal being a neo-colony itself, particularly of Britain. It lacked the human resources and capital to develop its own resources, let alone the enormous resources of its "empire".

In a vain attempt to stem the rising tide of nationalism and the resulting guerilla wars in its colonies, Portugal opened up its "empire" to international capital. In the minerals sector this resulted in the rapid development in the sixties of Angola's oil and iron ore resources. From 1960 to 1974 diamonds, oil and iron ore increased from 93.6% of the total value of mineral production to 99.4% and, over the same period, mineral exports increased from 19.4% to 60.8% of the total value of exports and the total (current) value of minerals extracted increased from 0.65 MKz to 18.5 MKz.

The new investment policy also led to a flurry of prospecting activity, particularly from the South African-based mining colossus, Anglo American-De Beers through their subsidiaries such as Condiama<sup>39</sup> and JCI (Johannesburg Consolidated Investment Company), but, unfortunately, this did not lead

to a concomitant expansion in systematic geological survey on the part of the colonial state. By 1974 only 20% of the country had been mapped at the large scale of 1:250,000. At the end of 1974 there were 20 companies with a total of 95 exclusive prospecting concessions including Diamang, Companhia Mineira do Lobito, Cabgoc, Petrangol, Empresa do Cobre de Angola and Condiama. At the end of the same year there were 1,631 claims on 226 mineral deposits<sup>40</sup>.

With the invasions of 1975/6 and South Africa's undeclared war of destabilisation until 1989, almost all the small-scale artisanal workings stopped, resulting in a situation at present where there are only two major minerals produced, oil and diamonds.

Backward and forward linkages between the minerals sector and the rest of the economy have been, and continue to be, almost non-existent. In terms of forward linkages, virtually all mineral production is exported, or vertically integrated into the developed market economies. About 10% of oil production is refined locally before export and all diamond production is exported, legally or illicitly. The only sector with high linkages is the tiny mineral building materials sector comprising, sand, clay, limestone, gypsum, stone and marble. In terms of backward linkages, there have never been industries, other than fuel, supplying mining inputs. All machinery, explosives, chemicals, plant, etc... have had to be imported.

Planned projects for further processing such as the urea and PVC plant based on natural gas (Soyo), the phosphate fertilizer plant (Kindonacaxa), the expansions of the refinery (Luanda) and the cement plant (Luanda), and the proposed DRI sponge iron and EAF steel plant, will retain some value in the country as well as making available limited amounts as inputs to local industry and agriculture, but the large majority of production, particularly oil, will still have to be exported due to the limited size of the domestic market. Investment by Sonangol into enterprises constructing equipment for the oil industry (Petromar) has managed to keep some of the value inside the country though these companies are themselves highly dependent on imported inputs.

The essential prerequisite to the development of the economy and with it the country's mineral resources is the ending, or at least diminishing of the war. This would not only open up for exploration and exploitation minerals in presently dangerous zones, but would also release enormous financial and human resources from the war effort. Defence is the largest recipient of the national budget, of scarce foreign exchange and of human resources. The key aspect to the ending of the war is the ending of US aid to UNITA and the closing of their bases in Zaire. UNITA has been able to receive open assistance from the USA, since the repeal of the Clarke Amendment (which banned aid to UNITA in 1976) in 1985, and is reported to be receiving 50 to 100 MUSD per annum.

In terms of the SADCC, Angola has the largest mineral complementarity in the region as all the other states import oil and/or oil products. SADCC oil consumption is about 4 ktOE/an, less than 20% of Angolan production. The main obstacle to Angola supplying the SADCC is that there is no operating rail or existing pipeline link to the rest of the region meaning that the oil and oil products would have to be shipped around the Cape to Beira and Dar es Salaam, giving it no cost advantage over oil from the Gulf. In addition the SADCC refineries (Zambia and Tanzania) were not designed to take Angolan crude. However, if the region was economically integrated it might make sense to build a pipeline to the Zambian refinery in Ndola (Indeni) then distribute the products to the region's consumers by rail and road.

The other areas where Angolan minerals might cater for regional demand are fertilisers (nitrogen and phosphate) and steel. However, for both there are also projects in Tanzania (Kilamco and Liganga) and

Mozambique (Pande and Honde) which may be more feasible. Angola could benefit from regional expertise in small to medium scale mining, particularly from Zimbabwe, and mining inputs (machinery, explosives, chemicals) could be imported from Zambia and Zimbabwe, but this would require the rehabilitation of the Benguela line (Lobito Corridor).

In conclusion, Angola is exceptionally rich in known mineral resources, even though the bulk of the country remains unexplored, but the only minerals developed have been oil and diamonds. The country has become increasingly mineral dependent due to the collapse of other sectors of the economy (in turn due to thirty years of war), particularly the coffee industry. In addition to the war, the other aspect limiting development is the acute shortage of managerial and professional personnel, due to a total neglect of indigenous training during Portuguese colonialism.

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### *Footnotes*

- 1 Rebelo 1988.
  - 2 Movimento Popular de Libertacao de Angola.
  - 3 Frente Nacional de Libertacao de Angola.
  - 4 Uniao Nacional de Independencia Total de Angola
  - 5 Andrade & Ollivier 1975.
  - 6 National Front for the Liberation of the Congo.
  - 7 Bhagavan 1986.
  - 8 SADCC 1985, page 44.
  - 9 GPRA 1978.
  - 10 Sonangol 1985.
  - 11 Dilolwa 1978.
  - 12 The August 1990 Gulf crisis oil price of 30 USD/bbl, would imply export earnings of 5 GUSD/annum.
  - 13 Rebelo 1988.
  - 14 Fina 1989.
  - 15 Liquid petroleum gas.
  - 16 DPSGM 1965, Dilolwa 1978.
  - 17 Dilolwa 1978, page 268.
  - 18 Dilolwa 1978.
  - 19 ex Roan Selection Trust of Zambia.
  - 20 Sociedade Portuguesa de Empreendimentos
  - 21 The CSO takes about 12% of the value to finance the international advertising campaign and the diamond stockpile.
  - 22 Diamond Counsellor International
  - 23 EIU Angola Country Report, 2/1989, page 15 and Africa Analysis No. 61, 1988.
  - 24 Dilolwa 1978.
  - 25 DSPSGM 1965 and "Metal Bulletin Iron Ore Special Issue 1969", page 21.
  - 26 UNIDO 1986b, page 12.
  - 27 Direct reduced iron.
  - 28 Electric arc furnace
  - 29 UNIDO 1989b.
  - 30 UNIDO 1986, volume II, page 5.
  - 31 DPSGM 1965 and Dilolwa 1978.
  - 32 UNTCD 1980.
  - 33 UNTCD 1980.
  - 34 UNTCD 1980.
  - 35 UNTCD 1980.
  - 36 Hodge 1978.
  - 37 DPSGM 1965.
  - 38 UNTCD 1980.
  - 39 Concorcio Mineiro de Angola.
  - 40 Gonsalves 1975.
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